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Editorial

Wireless Machine-to-Machine Networks 2013

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Machine-to-machine (M2M) technology allows direct communications between machine devices through wireless and/or wired systems without human intervention, which opens unique opportunities to businesses as well as consumers on cost reduction and services improvement. It holds huge potential for applications in a wide range of industries. It has been expected that there will be a huge increase in the number of machine devices enabled by wireless M2M technology and the amount of traffic generated by these devices in the next five years.

Due to the large diversities of the M2M applications (e.g., smart grids, smart home, wireless sensor networks, vehicle ad hoc networks, etc.) and M2M devices, various wireless network technologies (e.g., cellular networks, WiMAX, Wi-Fi, ZigBee, etc.) are likely to be applied jointly to effectively support M2M applications. However, the heterogeneous network technologies combined with the low-power machine devices and diverse QoS requirements of M2M applications present big challenges to the design and implementation of wireless M2M network protocols and algorithms.

Built on the last year's special issue on wireless M2M technologies and applications, this special issue continues to serve as a platform to gather researchers and engineers from different relevant areas, such as wireless sensor networks, RFID, WPAN, cellular networks and smart grid, to present the latest research advances on wireless M2M networks. Thirty papers have been accepted in this special issue. These papers are mainly focused on the following four research areas to address the main research challenges faced by wireless M2M networks, which are usually characterized by a large amount of low-power M2M devices, heterogeneous networks with limited bandwidth, and many coexisting applications with diverse QoS requirements: (1) developing advanced scalable wireless communication technologies and network architectures to improve network capacity; (2) designing and analyzing scalable wireless channel access and resource and interference management mechanisms for M2M applications; (3) designing and analyzing secure energy and bandwidth efficient network protocols; (4) designing and analyzing smart, adaptive, and self-organizing protocols and algorithms for dynamic wireless M2M networks.

In the paper entitled "*A dual-cycle architecture in cognitive M2M wireless networks*" by Y. Li et al. dual-cycle cognitive model (DCCM) applied develops large scale cognitive wireless networks, in which the structure and implementation of service-oriented radio architecture (SORA) are explored. Experiment results show that the proposed DCCM-based SORA is able to develop loose-coupled, reusable, and scalable heterogeneous wireless M2M networks. The paper entitled "*A performance analysis framework for WiFi/WiMAX heterogeneous metropolitan networks based on cross-layer design*" by M. H. Ochoa et al. propose a performance analysis framework (PAF) for heterogeneous wireless networks, which utilizes process algebra (PA) and the corresponding telecommunication traffic performance models and is applied to analysis of IEEE 802.16 and IEEE 802.11 protocols. In the paper entitled "*Multiple beam selection for combing M2M communication networks and cellular networks with limited feedback*" by

X. Zhang et al. a novel multiple beam selection (MBS) approach with limited feedback is proposed to provide network access to machine type devices in cellular networks by taking into account the orthogonal constraints. The paper entitled "*Random access control for M2M in LTE system*" by Z. Chen and Y. Zeng studied a random access control scheme for M2M devices in LTE system, which differentiates and controls access rates of users with different delay requirements. In the paper entitled "*Joint access control and subchannel allocation scheme for femtocell-based M2M network using a truthful mechanism*" by C. Li et al. a joint access control and subchannel allocation (JACSA) scheme is proposed for femtocell-based machine-to-machine (M2M) networks with both open access and hybrid access scenarios. In the paper entitled "*Collaborative relay beamforming based on minimum power for M2M devices in multicell systems*" by X. Zhang et al. relay beamforming strategies are studied to guarantee quality of service (QoS) requirements of multiple devices in multicell systems. In the paper entitled "*A utility-based rate allocation of M2M service in heterogeneous wireless environments*" by Y. Huang et al. a dynamic adaptive service rate allocation scheme is proposed to optimally distribute traffic from machine devices in heterogeneous wireless environments. The paper entitled "*A game-theoretic analysis of multiple protocol data flows in hierarchical M2M communication networks*" by G. Wang et al. proposes a new discriminatory user-based utility mechanism for data traffic from heterogeneous machine devices in hierarchical M2M networks.

In the paper entitled "*Mixed cooperation MAC protocol with sleep mechanism for data acquisition in wireless machine-to-machine networks*" by Y. Zhao et al. a mixed sleep-cooperative time division multiple access (TDMA) media access control (MAC) protocol is proposed for wireless M2M networks by exploring the idle state of each sensor node. In the idle state each sensor node dynamically goes into sleep state or cooperative state to maximize the network lifetime. The paper entitled "*A smart electronic tagging system based on context awareness and machine-to-machine interworking*" by G.-Y. Lee et al. presents a smart electronic tagging system, which connects a ubiquitous system network (USN) and Android mobile platforms to effectively track the locations of persons being monitored. In the paper entitled "*Design considerations of self-adaptive wireless M2M network communication architecture*" by X.-J. Chen et al. a concept of attribute assembly layer is proposed and an adaptive architecture for wireless M2M network is built, which unifies the data link layers for heterogeneous networks. In the paper entitled "*Passive synchronization based energy-efficient MAC protocol over M2M wireless networks*" by P. Sthapit and J.-Y. Pyun a new MAC protocol called passive synchronization based energy-efficient MAC (PSMAC) synchronizes nodes in their sleep states by using interrupts generated from a proposed radio-triggered hardware to provide diverse QoS with ultra-low power consumption and mobility support. In the paper entitled "*Multicast capacity analysis for high mobility social proximity machine-to-machine networks*" by X. Guan the multicast capacity of bus-assisted VANETs in forwarding scenario and routing scenario is studied. The paper entitled "*Trajectory optimization of packet ferries in opportunistic social-based machine-to-machine networks*" by X. Guan investigates the optimization problem of the moving trajectory by considering the minimum transmission delay for wireless M2M networks, which is studied by a semi-Markov decision process model. In the paper entitled "*Secure beamforming via amplify-and-forward relays in machine-to-machine communications*" by Z. Liu et al. collaborative amplify-and-forward relaying is applied to form a beamforming system and provide physical layer security for a wireless M2M communication network. The paper entitled "*EAP-based group authentication and key agreement protocol for machine-type communications*" by R. Jiang et al. presents a group authentication and key agreement protocol, called EG-AKA, for machine-type communications, which combines elliptic curve Diffie-Hellman (ECDH) based on EAP framework. The proposed protocol provides stronger security and better performance compared to conventional EAP-AKA scheme. The paper entitled "*The performance of multimessage algebraic gossip in a random geometric graph*" by G. Wang et al. proposed an information dissemination method based on algebraic gossip in a random geometric graph (RGG) to disseminate messages rapidly in large scale networks.

The paper entitled "*DAG based multipath routing algorithm for load balancing in machine-to-machine networks*" by L. Liu et al. presents a directed acyclic graph based multipath routing algorithm for congestion mitigation, where different routing paths are confined in a directed acyclic graph (DAG) under time delay constraint. In the paper entitled "*Channel estimation for relay-based M2M two-way communications using expectation-maximization*" by X. Xu et al. channel estimation method developed for relay-based M2M two-way communications is proposed, in which the expectation-maximization algorithm is utilized to provide the maximum likelihood solution in the presence of unobserved data through stable iterations.

In the paper entitled "*Damping based traffic allocation in wireless machine-to-machine communications networks*" by R. Yu et al. a new load balancing algorithm is proposed to distribute traffic over multiple available paths for wireless M2M networks.

The paper entitled "*Efficient and secure resource management in home M2M networks*" by Y. Lai et al. presents an efficient bandwidth measurement and resource management method for home M2M networks. In the paper entitled "*Elastic information management for air pollution monitoring in large-scale M2M sensor networks*" by Y. Ma et al. an elastic resource allocation strategy was proposed, which is a novel management technique based on elastic computing, for large-scale M2M sensor networks developed for air pollution monitoring. In the paper entitled "*A vector algebraic algorithm for coverage compensation in hybrid wireless sensor networks*" by N.-N. Qin et al. a vector algebra based algorithm is proposed by exploring redundant nodes as an extra dimension for coverage compensation to tackle the coverage hole problem in hybrid wireless sensor networks. In the paper entitled "*An energy-heterogeneous clustering scheme to avoid energy holes in wireless sensor networks*" by G. Bencan et al. energy consumption of nodes at different network areas is analysed and an energy-efficient clustering routing protocol

is proposed to improve network lifetime of wireless sensor networks. The paper entitled "*Survey of the DASH7 Alliance Protocol for 433 MHz wireless sensor communication*" by M. Weyn et al. presents a survey of an active RFID standard for wireless sensor communications, which covers comparisons to the general concepts, key techniques, and a software implementation of the standard.

The paper entitled "*Design and evaluation of a framework for cooperative and adaptive QoS control of DSRC network for road safety applications*" by W. Guan et al. presents a framework for cooperative QoS control for vehicle ad hoc networks and implementation, in which network feedback and cross-layer design are exploited to collaboratively achieve targeted QoS. In the paper entitled "*Connectivity analysis for free-flow traffic in VANETs: a statistical approach*" by C. Chen et al. statistical properties of direct and indirect connectivity in vehicular environment are analysed and exploited to provide insights to protocols design and improvement. In the paper entitled "*SDMA-based aeronautical machine-to-machine communications under SINR constraints*" by J. Xie et al. an SDMA-based aeronautical M2M communication system is proposed together with a low complexity user selection approach to achieve efficient use of limited spectrum for aeronautical M2M communications. In the paper entitled "*Outage probability of dual-hop relay system with interference and feedback delay in satellite M2M networks*" by Y. Lin et al. the outage probability of a dual-hop wireless M2M communication system using amplify-and-forward (AF) and decode-and-forward (DF) relaying schemes is analysed. The paper entitled "*An efficient emergency message broadcasting scheme in vehicular ad hoc networks*" by H. S. Dawood and Y. Wang presents an efficient emergency message broadcasting scheme with low overhead for road safety application to avoid multiple accidents and reduce traffic jams.

The thirty papers included in this special issue presented the latest research works on both protocol design and theoretic analysis for wireless M2M networks. We hope that this special issue can help our readers get a better understanding about the breadth and depth of the current research advances on wireless M2M networks and boost further research and practical developments in the field of wireless M2M networks.

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